Maximum Greenhouse Gas and Oil use Reductions

Many reporters and observers assume that battery electric vehicles (BEVs) such as the Nissan Leaf will reduce or even eliminate greenhouse gas (GHG) emissions, so there is much reporting on "green" EVs, etc. But BEVs will not significantly reduce GHGs in many parts of the country. The Department of Energy's Argonne National Laboratory has developed an extensive computer model that calculates the "well-to-wheels" GHGs for many different alternative fuel vehicles[1]. The GHGs from some alternative vehicles are shown in Table 1. For the average US grid mix, BEVs produce 337 grams/mile of CO_2-equivalent GHGs in 2010, much lower than a conventional gasoline ICV at 473 grams/mile, *but a long way from zero* as the EPA would have you believe with their window sticker that fools the American public by rating BEVs like the Nissan Leaf as having zero GHGs; they justify this hoax by counting only the tailpipe emissions from the car, ignoring all the CO_2 produced back at the power plant [much of it generated by burning coal, the dirtiest (highest carbon content) fuel.] And, of course, GHGs will rise and contribute to climate change no matter where that gas is emitted, so all sources of GHGs must be included in any assessment of the true GHG impact of alternative vehicles.

As shown in Table 1, the lowest GHGs are generated by fuel cell electric vehicles (FCEVs) running on hydrogen made from natural gas at 260 grams/mile in 2010. This table also shows projections out to 2035 based on the DOE's Energy Information Administration's estimate of future US Grid production sources in their 2011 "Annual Energy Outlook (AEO)." Even in 2035, a BEV would still generate 278 grams/mile of GHGs, less than a gasoline ICV at 411 grams/mile, but still far from zero and greater than a FCEV at 200 grams/mile. The last column shows the estimated GHGs by 2050 assuming 100% zero-carbon electricity from nuclear and renewable energy, and biomass as the feedstock for ethanol and hydrogen.

Table 1 Estimated "well-to-wheels" per vehicle greenhouse gas emissions for the average US grid mix and various alternative fueled vehicles through 2035 using the Argonne National Laboratory GREET Model 1.8_d_0.

Fuel feedstocks:	NG for H2, FTD & DME; corn for EtOH					NG	Biomass
Electrical grid:	US average electrical grid					AEO2011	all nuclear
Summary of GHGs over time	**grams/mile of CO2-eq.**					US Grid	
Vehicle	2010	2013	2015	2018	2020	2035	2050+
Gasoline ICV (CG&RFG)	532	457	480	421	464	411	405
E-85 ICV	498	427	449	395	434	385	380
Gasoline HEV (CG&RFG)	381	327	344	301	332	294	290
NGV	416	370	376	329	363	322	316
NG HEV	306	264	277	242	268	237	233
E-85 HEV	357	306	322	283	311	276	273
BEV	365	316	312	274	304	279	3
FCEV	260	226	234	200	226	200	2
NG PHEV	345	342	320	292	315	302	141
FC PHEV	325	379	301	271	297	285	3
CG & RFG PHEV	390	409	360	326	354	336	173
Grid-connected SI PHEV-40 E-85	207	141	194	187	194	194	43
Grid-connected CIDI PHEV-40 FT	411	442	379	339	372	353	15
Grid-connected CIDI PHEV-40 DI	389	409	359	324	353	336	4
Grid-Connected CIDI PHEV: BD2	358	363	331	302	326	312	149

(all PHEVs have 40 miles AER)

Car GHG and criteria pollutants (Rev C).XLS; WS 'Best Fuels' I54 10/29 /2011

BEV Reductions per vehicle displaced

NG = natural gas; FTD = Fischer-Tropsch Diesel; DME = dimethyl ether; EtOH = ethanol; AOE = Annual energy outlook; CG = conventional gasoline; RFG = reformulated gasoline; E-85 = mixture of 85% ethanol in gasoline; ICV = internal combustion engine (conventional) vehicle; NGV = natural gas vehicle; HEV = hybrid electric vehicle; BEV = battery electric vehicle; FCEV = fuel cell electric vehicle; PHEV = plug-in hybrid electric vehicle (Such as the Chevy Volt)

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[1] GREET = "Greenhouse gas, regulated emissions, and energy use in Transportation," by Michael Q. Wang at the Argonne National Laboratory model 1.8_d_0, available at http://greet.es.anl.gov/

Using these calculations of GHGs from individual vehicles, we have estimated the total reduction in GHGs that could be obtained by replacing *all* current gasoline vehicles with these alternative vehicles. Recent analysis of the US vehicle fleet revealed that even if **all** US small cars, vans, pickup trucks and SUVs and 50% of all midsize sedans were replaced by BEVs, and **all other US vehicles** were replaced with PHEVs with 40 miles all-electric range such as the Chevy Volt, then the GHGs could only be reduced by at most 27%, while hydrogen-powered FCEVs[2] could reduce GHGs by 51% as shown in Figure 1.

These results will be valid until at least 2035 according to the EIA projections for grid electricity, after which time both hydrogen and electricity may be generated from renewable sources, with subsequently larger decreases in GHGs and oil use.

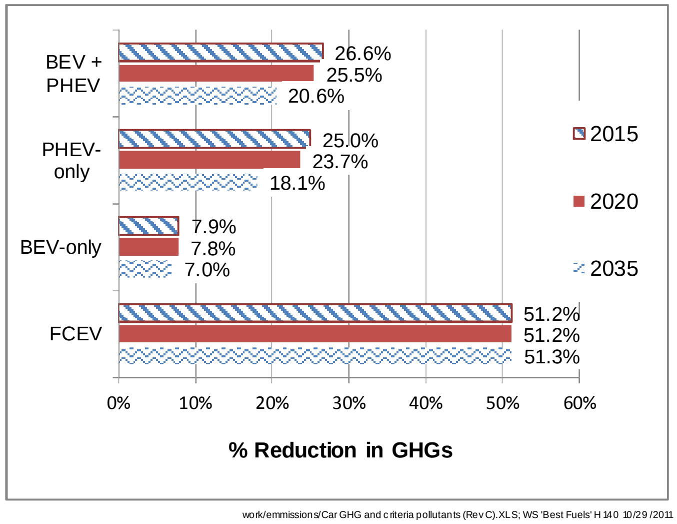


Figure 1. Maximum reductions (Large is good!) in greenhouse gases (GHGs) possible with 100% replacement of all US vehicles with the alternative vehicles shown on the graph, [except for the BEV-only scenario, where BEVs could replace only 39.6% of all US LDVs.]

The Argonne GREET model also calculates the total petroleum consumption for each alternative vehicle. While some might assume that a BEV running on electricity would consume no petroleum, the GREET model analyzes oil consumed in the total process of generating electricity to charge the vehicle. For example, petroleum products are used to mine coal, process that coal and then transport it to the electrical generation plants. So, as shown in Table 2, operating the power plants to supply electricity to BEVs does require some oil consumption. BEVs will effectively "consume" 102 btu's[3] of oil per mile in 2010, approximately four times more than FCEVs at 25 btu's/mile, but far less than the 5,808 btu's mile consumed by a conventional gasoline car. And plug-in hybrids such as the Chevy Volt will, on the average, consume 2,686 btu's of oil per mile traveled. The last column shows the estimated oil consumed after 2050 assuming 100% zero-carbon electricity from nuclear and renewable energy, and biomass as the feedstock for ethanol and hydrogen.

[2] Assuming that all hydrogen is made from natural gas.

[3] Btu = British thermal unit, a measure of the energy content in a given quantity of oil.

Table 2. Oil consumed to operate various alternative vehicles as calculated by the Argonne GREET model

Oil consumption

Fuel feedstocks:	NG for H2, FTD & DME; corn for EtOH					NG	Biomass
Electrical grid:	US average electrical grid					AEO2011	all nuclear
Summary of GHGs over time	**btu/mile**					US Grid	
Vehicle	2010	2013	2015	2018	2020	2035	2050+
Gasoline ICV (CG&RFG)	5,808	5,002	5,239	4,542	5,059	4,343	4,343
E-85 ICV	5,597	4,809	5,049	4,414	4,875	4,246	4,246
Gasoline HEV (CG&RFG)	4,149	3,573	3,742	3,245	3,614	3,102	3,102
NGV	32	28	28	25	27	24	24
NG HEV	23	20	21	18	20	18	18
E-85 HEV	3,998	3,435	3,606	3,153	3,482	3,033	3,033
BEV	102	89	85	79	83	73	4
FCEV	25	22	22	20	22	18	73
NG PHEV	57	39	52	52	52	50	13
FC PHEV	58	47	53	53	53	50	49
CG & RFG PHEV	2,689	3,815	2,436	2,043	2,358	1,905	1,868
Grid-connected SI PHEV-40 E-85	936	1,258	849	714	822	674	637
Grid-connected CIDI PHEV-40 FT	74	64	68	65	67	62	100
Grid-connected CIDI PHEV-40 DM	84	78	77	73	76	69	100
Grid-Connected CIDI PHEV: BD2	2,211	3,180	2,003	1,687	1,939	1,577	1,540

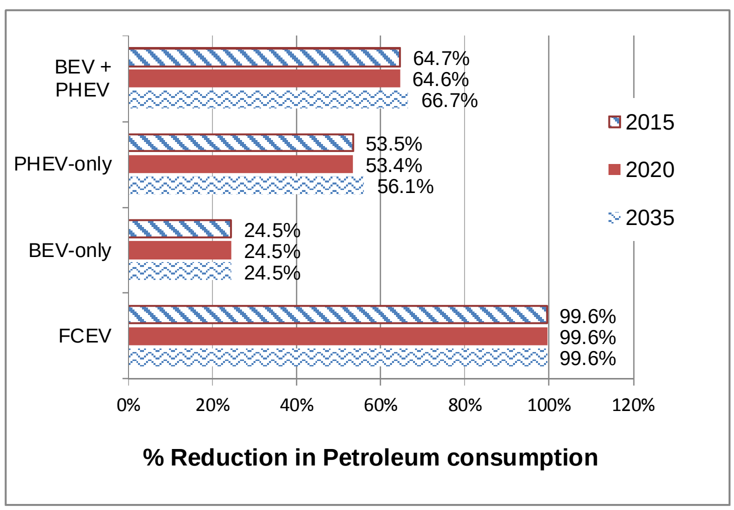
(all PHEVs have 40 miles AER)

Car GHG and criteria pollutants (Rev C).XLS; WS 'Best Fuels' S 54 10/29 /2011

BEV Reductions per vehicle displaced

With these data, we can calculate the total reduction in oil consumption if all US light duty vehicles were replaced by the alternatives. As shown in Figure 2, replacing all US vehicles with BEVs and PHEVs as proposed by the Obama administration would cut oil consumption by less than 61%, whereas replacing all vehicles with hydrogen-powered FCEVs would eliminate nearly all oil consumption[4].

Therefore limiting alternative vehicle choices to only BEVs and PHEVs as proposed by the DOE Secretary Chu and the Obama administration will severely limit our nation's ability to substantially cut GHGs or oil consumption until mid-century or later. The ill-advised decision by the administration to terminate the DOE's hydrogen and FCEV program is very short-sighted and dangerous; robbing future generations of their best tool for fighting our addiction to oil and climate change gases.



Car GHG and criteria pollutants (Rev C).XLS; WS 'Best Fuels' R 140 10/29 /2011

Figure 2.Maximum reductions (Large is good!) in oil consumption possible with 100% replacement of all US vehicles with the alternative vehicles shown on this graph

[4] As with BEVs, some oil would be required to process the hydrogen, including electricity to run hydrogen compressors, so the FCEV oil use is not strictly zero.